Soldier S&T Initiatives Support Current Operations and Future Force Warrior Technological Development

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The Natick Soldier Center's (NSC's) Soldier Science and Technology (S&T) effort focuses on enduring challenges facing the Soldier System. The Future Force Warrior (FFW) Advanced Technology Demonstration (ATD), the Army's flagship Soldier S&T program, is leading the charge for systemized development and integration of enhanced Soldier capabilities in survivability, sustainment, mobility, command and control and lethality. As the FFW ATD proceeds, feeder S&T efforts are spiraling toward planned insertions while making near-term transitions to support current operations wherever possible.

A Soldier models the new lower extremity protection prototype designed to provide leg and thigh protection from fragmentation. (NSC photo by Sarah Underhill.)

NSC Soldier S&T efforts cover the full range of Soldier-as-a-System (SaaS) technologies. Here, we will discuss some recent transitions to the Current Force and their associated long-term research areas related to survivability and sustainment.

Survivability — Enhancing Personal Protection

Personal body armor is issued and used by all troops deployed to *Operations Enduring Freedom (OEF)/Iraqi Freedom (OIF)*. The NSC-developed Interceptor Body Armor (IBA), setting the standard for protection, has benefited from numerous NSC S&T improvements to overcome the weight and producability issues of previous forms of body armor. However, the improvised explosive device threat in Iraq poses increased challenges, most notably protection to arms and legs. Extremity armor to provide upper arm and deltoid protection has been recently fielded through Program Executive Office Soldier's Rapid Fielding Initiative.

Originally proposed by a medical unit in the 82nd Airborne Division operating in Iraq, protection is provided to the upper shoulder and underarm, areas that have shown to be vulnerable to injury for drivers and passengers of wheeled vehicles. That work is now being extended to provide lower extremity protection. Prototypes are being evaluated that provide leg and thigh protection from fragmentation. A particular challenge in these systems is maintaining Soldier flexibility, dexterity and mobility while wearing the protection.

> NSC S&T offers many other avenues for improved Soldier survivability with new material solutions for combat clothing and equipment.

Balancing the trade-offs between improved survivability and increased Soldier-borne loads becomes easier with the emergence of new material technology. New high-performance fibers are the primary enabler for lighter weight body armor systems. One example is known as M5 Fiber, which is expected to provide a 30-percent reduction in the soft component of body armor (as well as helmet armor) and to reduce the rigid plate's weight by 15 percent. Improvements of this order will help protect against current threats and enable emerging threats to be addressed as well.

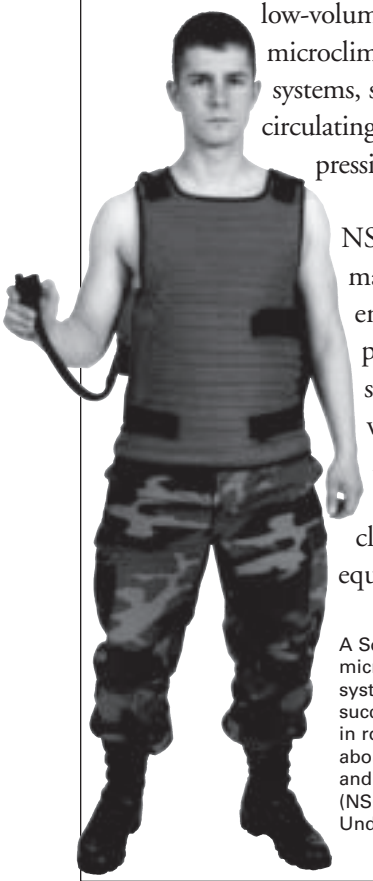
Another aspect of Soldier survivability is protection from harsh environments. One of the most significant non-enemy threats in Iraq has been the hot, humid environment, which causes extreme

NSC-developed body-worn combat ensemble will enhance dismounted Soldiers' battlefield effectiveness in the near future, leveraging and integrating technological advances as never before. (Image courtesy of NSC.)

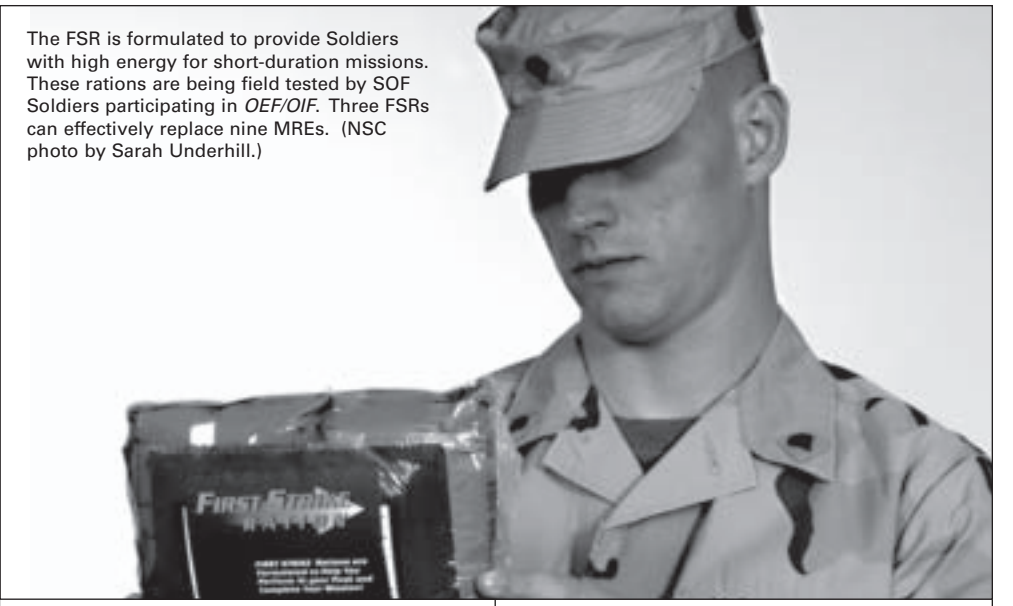
heat buildup in vehicles and heat burden to warfighters wearing body armor. In recent years, microclimate-cooling solutions have been successfully fielded for use in rotary-wing aircraft, on ships and by explosive ordnance disposal (EOD) personnel. The Army developmental community has come together to focus on cooling systems for Humvee occupants.

Systems providing either conditioned cabin air or microclimates to the crewman's body have been developed and evaluated, and limited quantities are being bought and fielded for forces in Iraq. The long-term goal is to develop microclimate-cooling solutions common to multiple tactical and armored vehicles. These innovations may also apply to the dismounted warrior with the advent of micropower generating devices. Near-term passive ventilation and active air blower systems are also being evaluated for Soldiers in IBA. Future activities include S&T investments focusing on the development of very lightweight, low-volume active microclimate-cooling systems, such as liquid circulating vapor compression systems.

NSC S&T offer many other avenues for improved Soldier survivability with new material solutions for combat clothing and equipment.



A Soldier models the microclimate-cooling system that has been successfully deployed in rotary-wing aircraft, aboard Navy vessels and by EOD personnel. (NSC photo by Sarah Underhill.)



The FSR is formulated to provide Soldiers with high energy for short-duration missions. These rations are being field tested by SOF Soldiers participating in *OEF/OIF*. Three FSRs can effectively replace nine MREs. (NSC photo by Sarah Underhill.)

Some of these improvements include fire-resistant clothing at reduced weight and cost; antimicrobial protection in battle dress items to reduce odor or the risk of infection to open wounds from prolonged wear; a universal camouflage pattern; and wrinkle-free technology for easy care of combat uniforms. Additional improvements include the introduction of electrotextiles into materials and garments to take the place of power-conducting and data-transmission cables, as well as to act as antennas, physiological sensors and even power-generating devices to reduce the need for batteries. S&T efforts in these areas will provide significant improvements in battle dress performance and, when integrated into single layers of materials, will enhance multiple capabilities without adding the burdens of weight or bulk to combat clothing and equipment.

FFW ATD incorporates human-centered design, enhanced biomechanic effects, scientifically optimized load distribution, improved reliability and human-machine interfaces and reduced weight while potentially enhancing ground Soldier capabilities and performance.

Soldier Technology for Special Forces

NSC develops items tailored to Special Operations Forces (SOF) applications, and successful transition of these items can yield benefits to the other services as well. The SOF fielding cycle, typically more rapid than the Army's, provides the necessary field experience to help accelerate adoption and fielding of Army and U.S. Marine Corps-equivalent items. Past efforts include development and fielding of the Advanced Combat Helmet (ACH), load-bearing equipment, boots, high-performance body armor and extreme cold weather clothing gear — all initially fielded to the SOF and ultimately adopted by the Army.

The second-shot penetration of Small Arms Protective Inserts is largely due to cracks generated from first-shot impact. An example solution developed for SOF is the Crack Arrestor

Technology (CAT) for body armor. CAT uses a carbon stiffener to limit the armor plate's flexing upon bullet impact, reducing the cracking at impact and improving the probability to prevent second-shot penetration. The plate's overall weight remained the same and no additional cost was added. NSC-developed technology solutions in support of the U.S. Special Operations Command allow the Army and other services to leverage the experience gained from SOF rapid developments. Ultimately, these SOF programs save the Army money, shorten product development time and help to standardize combat clothing and equipment across services.

Sustainment — the First Strike Ration (FSR)

Soldiers typically tailor their combat load for specialized missions. One technique is to field-strip rations based upon personal preferences for missions lasting up to 72 hours. This approach, while practical, can result in insufficient nutrition to meet the mission's physical demands, thereby reducing Soldier performance. To reduce this negative effect, the NSC Combat Feeding S&T produced the FSR. The FSR is to be issued on a one-per-day basis. The intent is to provide a full day's nutrition in one meal to substantially reduce the weight as compared to the standard Meal, Ready-to-Eat (MRE).

FSRs are designed for short-duration, high-energy missions and do not have sufficient balance of nutritional elements for extended use. The FSR has been successfully tested by SOF Soldiers during *OEF/OIF*, and with the Army in Germany and Afghanistan. For a 72-hour mission, three FSRs could effectively replace nine MREs. Longer-term efforts include developing technology for the nutritionally optimized FSR, which will provide a novel nutrient delivery system to improve energy intake (20 percent) and cognitive/physical performance (20 percent) compared to the FSR.

> NSC's balanced S&T portfolio continues to produce spiral insertion for products and systems, further enhancing Soldier capabilities during current operations.

FFW ATD

The FFW ATD is the Army's leading Soldier System S&T effort. Providing connectivity with the network and Future Combat Systems (FCS) to improve individual Soldier and small combat unit effectiveness, the FFW ATD also addresses four enduring challenges of the Soldier System concept — weight, power, fightability and affordability. With the goal of maximizing combat performance within human physical and cognitive limits, FFW ATD incorporates human-centered design, enhanced biomechanic effects, scientifically optimized load distribution, improved reliability and human-machine interfaces and reduced weight while potentially enhancing ground Soldier capabilities and performance.

The body-worn combat ensemble has many unique features to enhance the dismounted Soldier's combat

Because of climatic conditions in Afghanistan, Iraq and Kuwait, the Army developmental community has redoubled its efforts to provide more effective cooling systems for up-armored Humvees and other tactical vehicles. Long-term focus is on development of lightweight, low-volume active microclimate-cooling systems that employ liquid circulating vapor compression. (U.S. Air Force photo by SSGT Ashley Brokop.)

CWO Bill McCoy, a UH-60 Black Hawk helicopter pilot flying in an operation near Baghdad, Iraq, Jan. 23, 2005, benefits from the latest microclimate-cooling systems as he transports people and supplies across the hot desert expanses of Iraq. (U.S. Air Force photo by SSGT Angelique Perez.)

effectiveness. The body armor system has been integrated with a load carriage that creates a chassis for distributing loads across the entire torso. Furthermore, the design includes a series of pads to permit individual sizing and allow for passive cooling, with the added advantage that the standoff provided helps mitigate behind-armor effects. Load distribution also includes ballistic protective chaps, which enable load carriage across the thigh's large muscles. The chaps address the need for ballistic protective features for extremities to supplement the thoracic protection currently provided by IBA.

NSC specifically developed the ACH for SOF applications. The design was so effective that the Army and U.S. Marine Corps adopted it for general troop issue. (NSC photo by Sarah Underhill.)

Even the batteries will be ergonomically shaped and body conformal. Integrated into the ensemble is a suite of physiological status monitors that will allow individual Soldier health monitoring as well as remote triage by combat medics. New helmet designs will provide standard ballistic protection and accept radios, antennas and sensors on a plane through the center mass of the body rather than as currently placed, offset away from the helmet straining the neck muscles.

The ultimate goal is to develop novel, state-of-the-art technology prototypes that can detect and measure cognitive states and to identify how they can be integrated into command, control, communications, computers and intelligence systems. Identifying our warfighters' cognitive status will enable appropriate resource allocation to better adapt Soldiers to their current task environments.

The FFW ATD is critically important to the Army in developing and demonstrating a Soldier System-of-Systems (SoS) concept, with accompanying operational and system/technical architectures that directly support the FCS-equipped Unit of Action, netted communications and collaborative situational awareness. The ATD leverages and integrates technologies from across the Research, Development and Engineering Command, Defense Advanced Research Projects Agency and other government agencies. Likewise, it provides an SaaS technology foundation that can transition to the Land Warrior program and that supports a Soldier System modernization strategy addressing the Current and Future Force. The program will also initiate concept development for other SaaS variants (mounted and air) to meet FCS spiral insertion schedules for the Soldier System.

NSC's balanced S&T portfolio continues to produce spiral insertion for products and systems, further enhancing Soldier capabilities during current operations. At the same time, this portfolio maintains its focus on achieving unmatched future capabilities through integrated SoS technology development for the FFW ATD.

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